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University of
New Orleans

February 27, 1998

Dr. Alan Edelstein
Naval Research Laboratory
Program Officer
Code: 6342
4555 Overlook Avenue, SW
Washington, DC 20375-5326

Re: ONR Grant No. N00014-97-1-G005, Nanophase Synthesis of Magnetic Materials: Thick Film Ferrite Magnetic Materials, Combined Performance and Final Technical Report, February 12, 1998

Dear Dr. Edelstein:

Enclosed per the requirements of the above referenced Grant are three copies of our Combined Performance and Final Technical Report with SF-298 for the grant period beginning February 13, 1997, through February 12, 1998.

Sincerely yours,

Charles J. O'Connor, Ph.D.
Principal Investigator and
Director of AMRI

CJOC/ird

cc: Administrative Grants Officer (1 copy)
Director, Naval Research Laboratory (1 copy)
Defense Technical Information Center (1 copy)

NANOPHASE SYNTHESIS OF MAGNETIC MATERIALS:
Thick Film Ferrite Magnetic Materials
ONR Grant No. N00014-97-1-G005

COMBINED PERFORMANCE AND FINAL TECHNICAL REPORT
(Report No. ONR-021298)

February 12, 1998

Submitted to:

Naval Research Laboratory
Program Officer
Code: 6342
4555 Overlook Avenue, SW
Washington, DC 20375-5326

by

Charles J. O'Connor, Ph.D.
Principal Investigator and Director
Advanced Materials Research Institute
University of New Orleans, Lakefront
New Orleans, LA 70148

Signed:

Charles J. O'Connor, Ph.D. Date
Principal Investigator

COMBINED PERFORMANCE AND FINAL TECHNICAL REPORT
Grant No. N00014-97-1-G005
February 12, 1998

INTRODUCTION

The purpose of this report is to provide a combined performance and final technical report on the research activities performed by Dr. Charles J. O'Connor and his research group at the University of New Orleans under ONR Grant No. N00014-97-G005. The grant period is from February 13, 1997 to February 12, 1998. Included in this report are a general statement about the grant, a brief statement on the administrative activities associated with the grant, a brief summary of the research activities performed through this grant, and a list of presentations and papers derived in part with the support of this grant.

GENERAL STATEMENT ABOUT THE GRANT

The purpose of this grant was to support research on the fabrication and characterization of thick film ferrite magnetic materials as per our proposal dated January 1, 1997, entitled "Nanophase Synthesis of Magnetic Materials." This grant has provided initial funding for a much larger research program which was subsequently funded by DARPA to investigation of "Nanophase Magnetic Particles for Advanced Materials."

ADMINISTRATIVE ACTIVITIES

Key Personnel. The following key personnel were supported in part through this grant: Dr. Jin-Seung Jung (on sabbatical leave from Kangnung National University in Korea), as a post-doctoral researcher at AMRI, Everett Carpenter as a graduate assistant in Chemistry/AMRI, and Teresita Alcantara as a research associate at AMRI.

RESEARCH ACTIVITIES

The purpose of this grant was to support research on the fabrication and characterization of thick film ferrite magnetic materials as per our proposal dated January 1, 1997, entitled "Nanophase Synthesis of Magnetic Materials." Accordingly, through this grant we have continued our investigation of new synthetic routes for the preparation of nanophase magnetic materials. This grant has supported this work in three critical areas of materials research:

Preparation of Nanophase Materials in Restricted Environments. Of particular interest to our research group in the synthesis of nanophase magnetic materials is the use of self-assembly processes in the confined media of reversed micelles to prepare nanocomposite magnets with variable and temperature dependent remanence and

coercivity. In earlier work, we have been able to synthesize superparamagnetic ferrites and wide band-gap semiconductors (CdS and TiO_2) using such environments. We have pursued this line of work and have focused on the concept that particle nucleation in the restricted environment of reversed micelles leads to confined growth of nanoparticles. The nanoparticles which are produced remain suspended in the host liquid medium to form a stable ferrofluid. The fluid microstructure provides a template for the synthesis and formation of superparamagnetic nanoparticles. Thus, it is possible to synthesize magnetic nanoclusters which are functioalized onto, or which are encapsulated into, specific conjugated polymer matrices. Such syntheses are carried out in spatially and geometrically restricted environments which restrict the growth of the inorganic clusters to the nanometer scale and in the case of lipid gels, impose a three-dimensional ordering of the nanoclusters. These polymer-magnetic nanocomposites find varied applications in ferrofluid technology, information storage, magnetic refrigeration, magnetic separations, magnetooptics, and so on.

Encapsulation of Magnetic Nanoparticles in Polymer Microspheres. We have also continued the study of synthetic approaches for the encapsulation of superparamagnetic ferrite nanoparticles in polymer microspheres with controlled internal densities. Using the restricted environments of reversed micelles, we have been able to prepare polymer-ferrite nanocomposites which exhibit superparamagnetism. This synthetic approach is coupled with our interest in exploring the role of the matrix in modifying the magnetic characteristics of nanoscale particles which are embedded in the polymer matrix. Because the polymer used is a highly functionalizable material, polyphenol, the nanocomposite is well suited for applications in magnetic bioseparations and magnetic coatings.

Evaluation of the Properties of Polymer-Ferrite Nanocomposites. Through this grant, we have been able to continue our studies into the characterization of superparamagnetic and other physical properties of polymer-ferrite nanocomposites, including photomagnetic and magnetooptical response in nanocomposite materials.

This grant has provided support for our research in these three areas of materials science. Some of this work described above has provided data for presentation at conferences and in the literature as follows:

Papers Presented at Conferences and Workshops

"Nanoferrite - Polymer Composites from Reverse Micelles," Nanoscale Design of Magnetic Materials ARO Workshop, Research Triangle Park, NC, Sept. 17-19, 1997.

"Preparation of Mixed-Valence Titanates through a Correlated Two-Step Synthetic Process," R. A. McIntyre, A. U. Falster, J. L. Heintz, S. Li, C. J. O'Connor, W. B.

Simmons, Jr., and J. B. Wiley, 214th National American Chemical Society Meeting, Las Vegas, NV, Sept. 1997.

"A Two-Step Synthetic Process for the Enhanced Control Over Mixed Valency in Layered Perovskites," R. A. McIntyre, A. U. Falster, S. Li, C. J. O'Connor, W. B. Simmons, Jr., and J. B. Wiley, 214th National American Chemical Society Meeting, Las Vegas, NV, Sept. 1997.

"Magnetic Properties of Cobalt and Manganese Ferrite Nanoparticles Synthesized in Reversed Micelles," E.E. Carpenter, C.T. Seip, and C.J. O'Connor, 7th Joint MMM-Intermag Conference, San Francisco, CA, Jan. 1998.

Papers Accepted for Presentation at Conferences

"Synthesis and Magnetic Properties of Nanocomposites of a Core-Shell Structure," E.E. Carpenter, C.T. Seip, and C.J. O'Connor, 215th National American Chemical Society Meeting, Dallas, TX, March-April 1998.

Papers Accepted for Publication

"Magnetic Properties of a Series of Ferrite Nanoparticles Synthesized in Reverse Micelles, " C.T. Seip, E.E. Carpenter, C.J. O'Connor, V.T. John, and S. Li, IEEE Transactions on Magnetics, in press (1998).

Papers Published

"Ferrite Synthesis in Microstructured Media: Template Effects and Magnetic Properties," C.J. O'Connor, Y.S.L. Buisson, S. Li, S. Banerjee, R. Premchandran, T. Baumgartner, V.T. John, G.L. McPherson, J.A. Akkara, and D.L. Kaplan, J. Appl. Phys., 81, 4741-4743 (1997).

"Polymer Microsphere and Polymer-Ferrite Nanocomposite Preparation by Precipitation from Water-in-Oil Microemulsions," S. Banerjee, V.T. John, G.L. McPherson, C.J. O'Connor, Y.S.L. Buisson, J.A. Akkara, and D.L. Kaplan, Colloid Polym. Sci., 275, 930-37 (1997).

"Opening a Perovskite to Valence Manipulation: Two-Step Topotactic Route to a New Mixed-Valence Titanate, $Na_{1-x+y}Ca_{x/2}LaTiO_4$," R. A. McIntyre, A. U. Falster, S. Li, W. B. Simmons, Jr., C.J. O'Connor, and J. B. Wiley, J. Am. Chem. Soc, 120: 217-218 (1998).

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13. ABSTRACT *(Maximum 200 words)*

Research on the fabrication and characterization of thick film ferrite magnetic materials was conducted as part of our continuing studies on the nanophase synthesis of magnetic materials. This report describes briefly the three areas of materials research which were investigated: (1) the preparation of nanophase materials in restricted environments, (2) the encapsulation of magnetic nanoparticles in polymer microspheres, and (3) the evaluation of properties of polymer-ferrite nanocomposites.

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